Practitioner's Docket No. AP9641

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/EP00/04498	18/May/2000	18/May/1999
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

Sensor Unit and Sensor for Such a Unit
TITLE OF INVENTION

Peter LOHBERG
APPLICANT(S)

Box PCT
Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the*

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national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. §1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. §1.8.

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 C.F.R. § 1.494(f).

1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2.Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
[ ]*	TOTAL CLAIMS	6 - 20 =		x $ 18.00 =	$
	INDEPENDENT CLAIMS	1 - 3 =		x $ 84.00 =	
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $280.00				
BASIC FEE**	[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: [ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) ..... $100.00 [ ] and the above requirements are not met (37 CFR 1.492(a)(1)) ..... $710.00 [X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: [ ] has been paid (37 CFR 1.492(a)(2)) ..... $740.00 [ ] has not been paid (37 CFR 1.492(a)(3)) ..... $1040.00 [X] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $890.00				
	Total of above Calculations				= 890.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR 1.9, 1.27, 1.28)				-
	Subtotal				890.00
	Total National Fee				$ 890.00
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				
TOTAL	Total Fees enclosed				$ 890.00

*See attached Preliminary Amendment Reducing the Number of Claims.

i. [ ] A check in the amount of _____ to cover the above fees is enclosed.

ii. [X] Please charge Account No. 18-0013 in the amount of $ 890.00 . A duplicate copy of this sheet is enclosed.

**WARNING: *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

3. [X] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.*

a. [X] is transmitted herewith.

b. [ ] is not required, as the application was filed with the United States Receiving Office.

c. [ ] has been transmitted

i. [ ] by the International Bureau.
Date of mailing of the application (from form PCT/IB/308): _____.

ii. [ ] by applicant on _____.
Date

4. [X] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):

a. [X] is transmitted herewith.

b. [ ] is not required as the application was filed in English.

c. [ ] was previously transmitted by applicant on _____.
Date

d. [ ] will follow.

5. [ ] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: *The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.*

a. [ ] are transmitted herewith.
b. [ ] have been transmitted
   i. [ ] by the International Bureau.
   Date of mailing of the amendment (from form PCT/IB/308): _____.
   ii. [ ] by applicant on _____. Date
c. [ ] have not been transmitted as
   i. [ ] applicant chose not to make amendments under PCT Article 19.
   Date of mailing of Search Report (from form PCT/ISA/210): _____.
   ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [ ] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):
   a. [ ] is transmitted herewith.
   b. [ ] is not required as the amendments were made in the English language.
   c. [ ] has not been transmitted for reasons indicated at point 5(c) above.

7. [x] A copy of the international examination report (PCT/IPEA/409)
   [x] is transmitted herewith.
   [ ] is not required as the application was filed with the United States Receiving Office.

8. [x] Annex(es) to the international preliminary examination report
   a. [x] is/are transmitted herewith.
   b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [ ] A translation of the annexes to the international preliminary examination report
   a. [ ] is transmitted herewith.
   b. [ ] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115
   a. [ ] was previously submitted by applicant on _____. Date
   b. [x] is submitted herewith, and such oath or declaration
      i. [x] is attached to the application.
      ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.

iii. [ ] will follow.

Other document(s) or information included:

11. [x] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
    a. [x] is transmitted herewith.
    b. [ ] has been transmitted by the International Bureau.
       Date of mailing (from form PCT/IB/308): _____.
    c. [ ] is not required, as the application was searched by the United States International Searching Authority.
    d. [ ] will be transmitted promptly upon request.
    e. [ ] has been submitted by applicant on _____.
       Date

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
    a. [X] is transmitted herewith.
       Also transmitted herewith is/are:
       [X] Form PTO-1449 (PTO/SB/08A and 08B).
       [X] Copies of citations listed.
    b. [ ] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
    c. [ ] was previously submitted by applicant on _____.
       Date

13. [x] An assignment document is transmitted herewith for recording.

    A separate [x] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or[ ] FORM PTO 1595 is also attached.

    Continental Teves AG & Co., oHG
    Frankfurt, Germany

14. [X] Additional documents:
    a. [ ] Copy of request (PCT/RO/101)
    b. [x] International Publication No. WO00/70309
       i. [ ] Specification, claims and drawing
       ii. [x] Front page only
    c. [X] Preliminary amendment (37 C.F.R. § 1.121)
    d. [ ] Other

15. [X] The above checked items are being transmitted

a. [X] before 30 months from any claimed priority date.
b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on _____, namely:

_____
_____
_____

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. 18-0013.

[X] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

[X] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

[X] 37 C.F.R. 1.17 (application processing fees)
[X] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[ ] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of

allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[X] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

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09/980645

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AP9641

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Peter LOHBERG

Int'l Application No.: PCT/EP00/04498

Int'l Filing Date: 18/May/2000

Serial No.: Group Art Unit:

Filed: Herewith Examiner:

For: Sensor Unit and Sensor for Such a Unit

Attorney Docket No.: AP9641 Paper No.

Box PCT
Commissioner for Patents
Washington, D.C. 20231
Attn: EO/US

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the application as follows prior to examination on the merits.

IN THE CLAIMS

Please cancel claims 1-9 and add the following new claims.

CERTIFICATE OF MAILING/TRANSMISSION (37 CFR 1.8(a))

I hereby certify that this correspondence is, on the date shown below, being:

☑ deposited with the United States Postal Service with sufficient postage as Express Mail, Post Office to Addressee, Mailing Label No.: EL781402496US addressed to Box PCT, Commissioner for Patents, Washington, DC 20231

☐ transmitted by facsimile to the Patent and Trademark Office. to Examiner _____ at _____

Signature Joyce Krumpe

Joyce Krumpe

Date: 11/15/01

10. (New) SWT sensor for vehicles, comprising:

a first housing for the accommodation of at least one converter element,

a second housing for a signal processing unit,

an at least 4-pole connection between the first and the second housing, and

wherein said second housing includes a port for a control device, wherein the signal processing unit arranged in housing is an analog amplifier with a current output and provides an alternating current with an approximately sinusoidal shape.

11. (New) SWT sensor according to claim 10, wherein the second housing has a port designed as a 2-wire-connection, with a pin as signal output and a pin for the supply of operating voltage.

12. (New) SWT sensor according to claim 10, wherein the converter element is designed as a magneto-electric converter.

13. (New) SWT sensor according to claim 12, wherein the first housing comprises functional elements for positioning or carrying at least one magnet used for pre-loading the magneto-electric converter elements.

14. (New) SWT sensor according to claim 10, wherein said converter element is adapted to interface to a rotating member to pick up the speed of the rotating members.

15. (New) SWT sensor according to claim 10, wherein said converter element is adapted to interface to a tire to determine the flexation thereof.

REMARKS

Prior to a formal examination of the above-identified application, acceptance of the new claims and the enclosed substitute specification (under 37 CFR 1.125) is respectfully

requested. It is believed that the substitute specification and new claims will facilitate processing of the application in accordance with M.P.E.P. 608.01(q). The substitute specification and new claims are in compliance with 37 CFR 1.52 (a and b) and, while making no substantive changes, are submitted to conform this case to the formal requirements and long-established formal standards of U.S. Patent Office practice, and to provide improved idiom and better grammatical form.

The enclosed substitute specification is presented herein in both marked-up and clean versions.

STATEMENT

The undersigned, an attorney registered to practice before the office, hereby states that the enclosed substitute specification includes the same changes as are indicated in the mark-up copy of the original specification. The substitute specification contains no new subject matter.

Respectfully submitted,

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SUBSTITUTE SPECIFICATION: CLEAN COPY

AP9641

Sensor Unit and Sensor for Such a Unit

Technical Field

[0001] The present invention generally relates to sensors and more particularly relates to sensor assemblies that include signal processing circuitry.

Background of The Invention

[0002] It is intended to realize a unit for various sensoric arrangements or sensors for the detection of dynamic air gap changes with a general design concept, where the unit comprises shelf parts or ready-made sensors.

[0003] The invention generally serves applications in the area of mechanical engineering, particularly for brake and driving-dynamics systems in the automotive industry, and here primarily in the application sector of controlled systems with brake intervention like ABS and TCS. The main application sector, however, is the employment for ESP (driving stability control systems) and SWT (Sidewall Torsion, in which, for the determination of wheel forces and of wheel speed, the tire sidewall deformation of an motor vehicle wheel is measured via sensors and evaluated).

[0004] A specific tire suitable for SWT and an SWT sensor, respectively, are known from DE 196 20 582 A1 and DE 196 20 581 A1. Also known in the prior art are magnetically active machine parts for air gap modulation, in which basically all permanent-magnetic or ferromagnetic parts can be utilized, which are moved in the direction of the air gap in dependence on a physical quantity to be measured. Usually incremental encoders are used for this purpose. There is a distinction between ferromagnetic and permanent-magnetic encoders. Ferromagnetic encoders are, for example, toothed wheels, toothed washers, toothed rings or hole-punched discs. Permanent-magnetic encoders are usually ring-shaped or circular

arrangements of successive north/south pole areas embedded in rubber or some other mechanical carrier.

[0005] Substantial examples for the use of magnetized encoders are magnetized wheel bearing seals for an ASB system ("Active Sensor Bearing") for the detection of the wheel speed and the magnetized vehicle wheel, already mentioned above, for the detection of dynamic forces according to the SWT principle (Sidewall Torsion Sensors).

[0006] Sensor arrangements for the detection of air gap modulations by means of an encoder are generally known. For instance, they also serve for the determination of crankshaft and camshaft positions in motor vehicle engines. In another typical application for the measurement of wheel speeds, an incremental encoder track periodically modulates the magnetic field strength in the air gap between two fixed values. An additional change of the kinematics between the sensor and the encoder through dynamic forces during driving operation and the herewith additionally occurring modulation of the field strength is undesirable in this application and is suppressed during signal-conditioning.

[0007] To this end, the so-called active sensors known from the prior art for ABS wheel speed detection contain an internal amplifier/trigger circuit that effects that, regardless of the air gap dynamics, always a square wave signal with two possible states is generated, whose edge change follows the encoder track.

[0008] For the detection of driving-dynamical states (ESP) of a motor vehicle, e.g. during cornering, it is suggested, for example in DE 44 42 355 A1, to draw on the value of an elastic axle deformation and, for its measurement, to use the width of the air gap between a wheel speed sensor and its respective encoder.

[0009] For the determination of longitudinal and lateral forces, it is known from DE 44 35 160 A1 to detect as well the phase of two wheel speed sensor signals as their variable signal amplitudes on a magnetically encoded tire by way of air gap deformations.

[0010] The objective of the present invention is to provide sensors equally suitable for all above-described sensor types, in which concept modular sensor units are formed, whose basic system is suitable for all sensors. It is further the objective of the present invention to create a sensor, in particular an SWT sensor, suitable for this concept of the formation of common units.

Summary of The Invention

[0011] A first inventive idea consists in generally designing future sensor units constructively in a way that their housing dimensions and outer shape is identical or nearly identical with sensor elements already in use for the production of active ABS wheel speed sensors (ready to use with cable and plug). This yields the advantage that, for the introduction of series production of novel sensors, e.g. SWT sensors, the same production tools can be used as for active wheel speed sensors.

[0012] Due to the great variety of different series programs for active sensors, there is an abundance of already existing different shape designs and constructive embodiments of active wheel speed sensors with the corresponding production tools, from which matching shapes can be steadily adopted for SWT sensors. In this way, the development expenditure is minimized, and the advantage is attained that also small SWT equipment numbers can be served economically. This basic thought also applies to future active sensors for wheel speed detection.

[0013] Further on, using the above concept, an inventive arrangement is described with which air gap modulations of any kind can be detected so that with these, beside the wheel speed, also air gap changes can be measured as a function of deformation forces. These sensors are particularly suitable for the realization of the sidewall torsion concept, yet as well for the realization of sensor systems for ESP based on DE 44 42 355 A1.

Brief Description of The Drawings

[0014] Fig. 1 a shows a basic structure of the inventive sensor unit.

[0015] Fig. 1 b-c show different variants of sensors based on the same concept.

[0016] Fig. 2 a-b show schematic illustrations of sensor circuits with functional blocks.

[0017] Fig. 3 a-b show the course of signal currents J_1 and J_2 over the time.

Detailed Description of The Preferred Embodiments

[0018] In connection with Fig. 1 a-d, at first a general concept for the standardized design of units for the active-sensor scanning of encoders is described, which are processed into ready-made sensors (probes) or which comprise common modular units according to the invention, respectively.

[0019] Fig 1a shows an outer housing shape or basic structure, respectively, of a general sensor element according to the inventive design concept. Here reference numeral 1 identifies a housing or head 1, preferably made of plastic, in which a magneto-electric converter element is embedded. A housing 2, preferably made of plastic, that is also called body 2. Body 2, contains some embedded electronic signal processing circuit. The intended application determines what converter element is contained in head 1 and what signal processing circuit in body 2. A permanent 4-pole electric connection 3 extends between head 1 and body 2. For a 2-wire connection to a control device, a pin 4 serves as signal output and a pin 5 for the supply with operating voltage.

[0020] Figures 1b, 1c, and 1d show the general housing shape according to Fig. 1a combined with three differently sized magnets 6, 7, and 8. These magnets serve for the demand-assigned different magnetic pre-load of electro-magnetic converters in head 1. Following the inventive thought of the design concept, three different magnets 6,7,8 have fixed dimensions so that general design variants exist now, whose content can be exchanged or adapted in head 1 or body 2 according to the application.

[0021] In an advantageous application, the constructive dimensions of the design variants correspond at the same time those of already existing active wheel speed sensors.

[0022] A further advantage of the inventive design concept consists in always realizing the following four interface properties. A 2-wire connection to the control device, operation with a wide range of uncontrolled supply voltage, load-independent current as carrier of the output signal as well as a continuous frequency resolution up to the standstill of the encoder.

[0023] Preferably, magneto-electric converters are exclusively used which are based on XMR technologies (concerning this, see Verlag VDI-Technologiezentrum, Düsseldorf, "Technologieanalyse Magnetismus", Vol. 2). Here particularly AMR technology (anisotropic magneto-resistance) and GMR (giant magneto-resistance).

[0024] The design variants are consistently used with a significant advantage as follows: The variant according to Fig. 1a in combination with permanent-magnetic encoders, the design variant according to Fig. 1b in combination with ferromagnetic encoders, the design variant according to Fig. 1c in combination with ferromagnetic encoders, and the variant according to Fig. 1d in combination with permanent-magnetic encoders.

[0025] Applications of the new design concept according to the invention are, among others, active wheel speed sensors with digital offset compensation according to patent application DE 198 15 084 A1, in which the head 1 comprises a magneto-resistive bridge and a barber pole structure as well as an ASIC for digital offset compensation. ASICs are integrated circuits (ICs) specifically designed for the application.

[0026] Additionally, the invention is suitable for active wheel speed sensors with transmission of additional information and a novel data protocol according to DE 196 34 715 A1. A head 1 with magneto-resistive bridge and barber pole structure, in which an IC or ASIC is employed for the recognition of direction and for the diagnosis of the air gap.

[0027] The inventive sensor unit can also be employed as an active sensor for the simultaneous detection of wheel speed and dynamic air gap deformation. Such a sensor can be utilized with a significant advantage for ESP or SWT, respectively. In this case, the sensor preferably includes a head 1 with a magneto-resistive bridge and a body 2 with an ASIC, in

particular of the type UA1272. Preferably, this sensor is designed according to one of the design variants according to Fig. 1 b-d.

[0028] Subsequently, such a sensor according to the invention as well as its adaptation to the inventive concept of the sensor units is described in further detail. The intended components of realization are mentioned in the preceding paragraph.

[0029] As previously explained, There are sensor elements for active wheel speed sensors, which can be integrated into the design concept and are currently manufactured in large numbers. To this end, Fig. 2b shows a schematic illustration of an electronic circuit with functional blocks of an active wheel speed sensor, and Fig. 2a shows a schematic illustration of the sensor according to the invention. Both depictions show at the same time the constructive allocation of the functional blocks into the superordinate design concept according to Fig. 1.

[0030] Preferably the same crystal module should be used for the detection of the air gap modulation that is already present as a standard component of sensor elements for active ABS wheel speed sensors and manufactured in large numbers. This yields the economic advantage that also small SWT equipment numbers can be served more economically. At the same time, the total number of crystal modules produced is increased (reducing the cost per unit).

[0031] Both heads 1 contain a magnetoresistive bridge circuit 9 of the same type. The magneto-electric converters 9 are, by way of an air gap not depicted here, magnetically coupled to a permanent-magnetic encoder track 10, which is preferably arranged in the sidewall of a magnetized tire or in a magnetized wheel bearing seal. The heads 1 are connected to the bodies 2 through the mentioned 4-pole connections 3. To the respective control device, there is the above-mentioned 2-wire connection via pin 4 and pin 5.

[0032] The voltage supply V_{cc} is established by way of the respective pin 5 from an electric control or regulating unit for the brake system. The signal processing circuits contained in bodies 2 differ by the schematically shown units 12 and 13 so that the signal currents J_1 and J_2 are significantly different.

[0033] In the known active sensor according to Fig. 2b, every fluctuation of amplitude, caused by dynamic air gap deformation, is suppressed by an amplifier or trigger stage, and the signal is shaped into an accurate, load-independent rectangular signal current J_2 with two constant amplitudes so that the transmitted information is limited to the wheel speed which is mapped in the sequence of edges.

[0034] In the inventive arrangement according to Fig. 2a, however, there is located an electronic circuit 12 amplifying and processing the signal so that a signal current J_1 is supplied to the control device 11, from which signal current additionally, beside the wheel speed information 14, the gauge of the amplitude can be gathered as a measurement for the thickness of the air gap 15 and the phase relation 16 to a reference signal.

[0035] Figs. 3a and 3b clarify once more the differences of the signal currents J_1 and J_2 between the known active sensor of Fig. 3b and the inventive sensor according to Fig. 3a under the same interface conditions to the encoder. Under the presumption of an air gap variation shown here, both sensors map the same wheel speed, however, only the inventive sensor additionally also the amplitude changing with the air gap width.

[0036] In an advantageous embodiment of the invention for the realization of an SWT sensor, the previously described arrangement can for instance be designed according to the following characteristics:

- a magnetic sensitivity (output current amplitude/encoder field strength) of S = .75 mA/[kA/m]
- an output current amplitude range of J = 11 mA ± 4 mA lift
- a terminal voltage range at pin 4 of V_{CC} = 5 to 16 V
- an output impedance of ≥ 10 kOhm.

[0037] The magnetized tire sidewall as encoder track can, for instance, be equipped with a pole pattern of 48 north/south pole pairs per 360° sidewall and with a magnetic field strength amplitude of .8 kA/m at 10 mm air gap.

[0038] In an advantageous embodiment of the invention for the realization of an SWT sensor, the sensor arrangement is realized according to the inventive design concept by utilizing the following units. Head 1 comprises a magnetoresistive bridge 9, body 2 includes an ASIC of the type UA1272. Preferably, the sensor is designed according to the embodiment of Fig. 1b, 1c, or 1d.

AP9641

Sensor Unit and Sensor for Such a Unit

Abstract of The Invention

[0039] The invention relates to a sensor unit and a sensor for such a unit for vehicles, in particular motor vehicles. According to the invention, in order to provide a concept equally suitable for different sensor types, in which modular sensor units are formed and whose basic system is suitable for all sensors, a first housing for the accommodation of at least one converter element a second housing for the accommodation of a signal processing unit, an at least 4-pole connection between the first and the second housing, and a port of the second housing for a control device are provided.

SUBSTITUTE SPECIFICATION: MARKED UP COPY

AP9641

[PC 9641]

Sensor Unit and Sensor for Such a Unit

Technical Field

The present invention generally relates to sensors and more particularly relates to sensor assemblies that include signal processing circuitry [relates to a sensor unit as well as a sensor for such an unit according to the preamble of patent claim 1 and the preamble of claim 6, respectively].

Background of The Invention

It is intended to realize a unit for various sensoric arrangements or sensors for the detection of dynamic air gap changes with a general design concept, where the unit comprises shelf parts or ready-made sensors.

The invention generally serves applications in the area of mechanical engineering, [yet] particularly for brake and driving-dynamics systems in the automotive industry, and here primarily in the application sector of controlled systems with brake intervention like ABS and TCS. The main application sector, however, is the employment for ESP (driving stability control systems) and SWT (Sidewall Torsion, in which, for the determination of wheel forces and of wheel speed, the tire sidewall deformation of an motor vehicle wheel is measured via sensors and evaluated).

A specific tire suitable for SWT and an SWT sensor, respectively, are known from DE 196 20 582 A1 and DE 196 20 581 A1. Also known in the prior art are magnetically active machine parts for air gap modulation, in which basically all permanent-magnetic or ferromagnetic parts can be utilized, which are moved in the direction of the air gap in dependence on a physical quantity to be measured. Usually incremental encoders are used for this purpose. There is a distinction between ferromagnetic and permanent-magnetic encoders.

Ferromagnetic encoders are, for example, toothed wheels, toothed washers, toothed rings or hole-punched discs. Permanent-magnetic encoders are usually ring-shaped or circular arrangements of successive north/south pole areas embedded in rubber or some other mechanical carrier.

Substantial examples for the use of magnetized encoders are magnetized wheel bearing seals for an ASB system ("Active Sensor Bearing") for the detection of the wheel speed and the magnetized vehicle wheel, already mentioned above, for the detection of dynamic forces according to the SWT principle (Sidewall Torsion Sensors).

Sensor arrangements for the detection of air gap modulations by means of an encoder are generally known. For instance, they also serve for the determination of crankshaft and camshaft positions in motor vehicle engines. In another [classical case of] typical application[,] for the measurement of wheel speeds, an incremental encoder track periodically modulates the magnetic field strength in the air gap between two fixed values. An additional change of the kinematics between the sensor and the encoder through dynamic forces during driving operation and the herewith additionally occurring modulation of the field strength is undesirable in this application and is suppressed during signal-conditioning.

To this end, the so-called active sensors known from the prior art for ABS wheel speed detection contain an internal amplifier/trigger circuit that effects that, regardless of the air gap dynamics, always a square wave signal with two possible states [constant amplitudes] is generated, whose edge change follows the encoder track.

For the detection of driving-dynamical states (ESP) of a motor vehicle, e.g. during cornering, it is suggested, for example in DE 44 42 355 A1, to draw on the value of an elastic axle deformation and, for its measurement, to use the width of the air gap between a wheel speed sensor and its respective encoder.

For the determination of longitudinal and lateral forces, it is known from DE 44 35 160 A1 to detect as well the phase of two wheel speed sensor signals as their variable signal amplitudes on a magnetically encoded tire [via] by way of air gap deformations.

The objective of the present invention is to provide [a concept] sensors equally suitable for all above-described sensor types, in which concept modular sensor units are formed, whose basic system is suitable for all sensors. It is further the objective of the present invention to create a sensor, in particular an SWT sensor, suitable for this concept of the formation of common units.

[This objective is achieved, according to the invention, by means of the features of the patent claims 1 and 6, respectively.]

Summary of The Invention

A first inventive idea consists in generally designing future sensor units constructively in a way that their housing dimensions and outer shape is identical or nearly identical with sensor elements already in use for the production of active ABS wheel speed sensors (ready to use with cable and plug). This yields the advantage that, for the introduction of series production of novel sensors, e.g. SWT sensors, the same production tools can be used as for active wheel speed sensors.

Due to the great variety of different series programs for active sensors, there is an abundance of already existing different shape designs and constructive embodiments of active wheel speed sensors with the corresponding production tools, from which matching shapes can be steadily adopted for SWT sensors. In this way, the development expenditure is minimized, and the advantage is attained that also small SWT equipment numbers can be served economically. This basic thought also applies to future active sensors for wheel speed detection.

Further on, using the above concept, an inventive arrangement is described with which air gap modulations of any kind can be detected so that with these, beside the wheel speed, also air gap changes can be measured as a function of deformation forces. These sensors are particularly suitable for the realization of the sidewall torsion concept, yet as well for the realization of sensor systems for ESP based on DE 44 42 355 A1.

[Further advantages and preferred embodiments of the present invention arise from the subclaims as well as from the following description in connection with the attached drawings. In the drawings,]

Brief Description of The Drawings

Fig. 1 a shows a basic structure of the inventive sensor unit[;].

Fig. 1 b-c show different variants of sensors based on the same concept[;].

Fig. 2 a-b show schematic illustrations of sensor circuits with functional blocks[; and].

Fig. 3 a-b show the course of signal currents J_1 and J_2 over the time.

Detailed Description of The Preferred Embodiments

In connection with Fig. 1 a-d, at first a general concept for the standardized design of units for the active-sensor scanning of encoders is described, which are processed into ready-made sensors (probes) or which comprise common modular units according to the invention, respectively.

Fig 1a shows an outer housing shape or basic structure, respectively, of a general sensor element according to the inventive design concept. Here reference numeral 1 identifies a housing or head 1, preferably made of plastic, in which a [always some] magneto-electric converter element is embedded. [2 identifies a] A housing 2, preferably made of plastic, that [further on will also be] is also called body 2. [In body] Body 2, [there is always] contains some embedded [some] electronic signal processing circuit. The intended application determines what converter element is contained in head 1 and what signal processing circuit in body 2. A permanent 4-pole electric connection 3 extends between head 1 and body 2. For a 2-wire connection to a control device, a pin 4 serves as signal output and a pin 5 for the supply with operating voltage.

Figures 1b, 1c, and 1d show the general housing shape according to Fig. 1a combined with three differently sized magnets 6, 7, and 8. These magnets serve for the demand-assigned different magnetic pre-load of electro-magnetic converters in head 1. Following the inventive thought of the design concept, three different magnets 6,7,8 have fixed dimensions so that general design variants exist now, whose content can be exchanged or adapted in head 1 or body 2 according to the application.

In an advantageous application, the constructive dimensions of the design variants correspond at the same time those of already existing active wheel speed sensors.

A further advantage of the inventive design concept consists in always realizing the following four interface properties. A 2-wire connection to the control device, operation with a wide range of uncontrolled supply voltage, load-independent current as carrier of the output signal as well as a continuous frequency resolution up to the standstill of the encoder.

Preferably, magneto-electric converters are exclusively used which are based on XMR technologies (concerning this, see Verlag VDI-Technologiezentrum, Düsseldorf, "Technologieanalyse Magnetismus", Vol. 2). Here particularly AMR technology (anisotropic magneto-resistance) and GMR (giant magneto-resistance).

The design variants are consistently used with a significant advantage as follows: The variant according to Fig. 1a in combination with permanent-magnetic encoders, the design variant according to Fig. 1b in combination with ferromagnetic encoders, the design variant according to Fig. 1c in combination with ferromagnetic encoders, and the variant according to Fig. 1d in combination with permanent-magnetic encoders.

Applications of the new design concept according to the invention are, among others, active wheel speed sensors with digital offset compensation according to patent application DE 198 15 084 A1, in which the head 1 comprises a magneto-resistive bridge and a [Barber] barber pole structure as well as an ASIC for digital offset compensation. ASICs are integrated circuits (ICs) specifically designed for the application.

Additionally, the invention is suitable for active wheel speed sensors with transmission of additional information and a novel data protocol according to DE 196 34 715 A1. A head 1 with magneto-resistive bridge and [Barber] barber pole structure, in which an IC or ASIC is employed for the recognition of direction and for the diagnosis of the air gap[, is also conceivable].

[Another conceivable application of the] The inventive sensor unit [is] can also be employed as an active sensor for the simultaneous detection of wheel speed and dynamic air gap deformation. Such a sensor can be utilized with a significant advantage for ESP or SWT, respectively. In this case, the sensor preferably includes a head 1 with a magneto-resistive bridge and a body 2 with an ASIC, in particular of the type UA1272. Preferably, this sensor is designed according to one of the design variants according to Fig. 1 b-d.

Subsequently, such a sensor according to the invention as well as its adaptation to the inventive concept of the sensor units is described in further detail. The intended components of realization are mentioned in the preceding paragraph. [The variants of the constructive completion follow the guideline of the design concept claimed by the invention].

As previously explained, There are sensor elements for active wheel speed sensors, which can be integrated into the design concept and are currently manufactured in large numbers. To this end, Fig. 2b shows a schematic illustration of an electronic circuit with functional blocks of [a n] an active wheel speed sensor, and Fig. 2a shows a schematic illustration of the sensor according to the invention. Both depictions show at the same time the constructive allocation of the functional blocks into the superordinate design concept according to Fig. 1.

Preferably the same crystal module should be used for the detection of the air gap modulation that is already present as a standard component of sensor elements for active ABS wheel speed sensors and manufactured in large numbers. This yields the economic advantage that also small SWT equipment numbers can be served more economically. At the same time, the total number of crystal modules produced is increased[, which become cheaper that way] (reducing the cost per unit).

Both heads 1 contain a magnetoresistive bridge circuit 9 of the same type. The magneto-electric converters 9 are, [via] by way of an air gap not depicted here, magnetically coupled to a permanent-magnetic encoder track 10, which is preferably arranged in the sidewall of a magnetized tire or in a magnetized wheel bearing seal. The heads 1 are connected to the bodies 2 through the mentioned 4-pole connections 3. To the respective control device, there is the above-mentioned 2-wire connection via pin 4 and pin 5.

The voltage supply V_{cc} is established [via] by way of the respective pin 5 from an electric control or regulating unit for the brake system. The signal processing circuits contained in bodies 2 differ by the schematically shown units 12 and 13 so that the signal currents J_1 and J_2 are significantly different[, too].

In the known active sensor according to Fig. 2b, every fluctuation of amplitude, caused by dynamic air gap deformation, is suppressed by an amplifier or trigger stage, and the signal is shaped into an accurate, load-independent rectangular signal current J_2 with two constant amplitudes so that the transmitted information is limited to the wheel speed which is mapped in the sequence of edges.

In the inventive arrangement according to Fig. 2a, however, there is located an electronic circuit 12 amplifying and processing the signal so that a signal current J_1 is supplied to the control device 11, from which signal current additionally, beside the wheel speed information 14, the gauge of the amplitude can be gathered as a measurement for the thickness of the air gap 15 and the phase relation 16 to a reference signal.

Figs. 3a and 3b clarify once more the differences of the signal currents J_1 and J_2 between the known active sensor of Fig. 3b and the inventive sensor according to Fig. 3a under the same interface conditions to the encoder. Under the presumption of an air gap variation shown here, both sensors map the same wheel speed, however, only the inventive sensor additionally also the amplitude changing with the air gap width.

In an advantageous embodiment of the invention for the realization of an SWT sensor, the previously described arrangement can for instance be designed according to the following characteristics:

[To this end, the SWT sensor has]

- a magnetic sensitivity (output current amplitude/encoder field strength) of S = .75 mA/[kA/m][,]
- an output current amplitude range of J = 11 mA ± 4 mA lift[,]
- a terminal voltage range at pin 4 of V_{CC} = 5 to 16 V[, and]
- an output impedance of ≥ 10 kOhm.

The magnetized tire sidewall as encoder track can, for instance, be equipped with a pole pattern of 48 north/south pole pairs per 360° sidewall and with a magnetic field strength amplitude of .8 kA/m at 10 mm air gap.

In an advantageous embodiment of the invention for the realization of an SWT sensor, the sensor arrangement is realized according to the inventive design concept by utilizing the following units. Head 1 comprises a magnetoresistive bridge 9, body 2 includes an ASIC of the type UA1272. Preferably, the sensor is designed according to the embodiment of Fig. 1b, 1c, or 1d.

AP9641

[Abstract]

Sensor Unit and Sensor for Such a Unit

Abstract of The Invention

The invention relates to a sensor unit and a sensor for such a unit for vehicles, in particular motor vehicles. According to the invention, in order to provide a concept equally suitable for different sensor types, in which modular sensor units are formed and whose basic system is suitable for all sensors, a first housing [(1)] for the accommodation of at least one converter element a second housing [(2)] for the accommodation of a signal processing unit, an at least 4-pole connection [(3)] between the first and the second housing, and a port [(4,5)] of the second housing [(2)] for a control device are provided.

[(Fig. 1)]

3/PRTS

PC 9641

Sensor Unit and Sensor for Such a Unit

The present invention relates to a sensor unit as well as a sensor for such an unit according to the preamble of patent claim 1 and the preamble of claim 6, respectively.

It is intended to realize a unit for various sensoric arrangements or sensors for the detection of dynamic air gap changes with a general design concept, where the unit comprises shelf parts or ready-made sensors.

The invention generally serves applications in the area of mechanical engineering, yet particularly for brake and driving-dynamics systems in the automotive industry, and here primarily in the application sector of controlled systems with brake intervention like ABS and TCS. The main application sector, however, is the employment for ESP (driving stability control systems) and SWT (Sidewall Torsion, in which, for the determination of wheel forces and of wheel speed, the tire sidewall deformation of an motor vehicle wheel is measured via sensors and evaluated).

A specific tire suitable for SWT and an SWT sensor, respectively, are known from DE 196 20 582 A1 and DE 196 20 581 A1. Also known in the prior art are magnetically active machine parts for air gap modulation, in which basically all permanent-magnetic or ferromagnetic parts can be utilized, which are moved in the direction of the air gap in dependence on a physical quantity to be measured. Usually incremental encoders are used for this purpose. There is a distinction between ferromagnetic and permanent-magnetic encoders. Ferromagnetic encoders are, for

example, toothed wheels, toothed washers, toothed rings or hole-punched discs. Permanent-magnetic encoders are usually ring-shaped or circular arrangements of successive north/south pole areas embedded in rubber or some other mechanical carrier.

Substantial examples for the use of magnetized encoders are magnetized wheel bearing seals for an ASB system ("Active Sensor Bearing") for the detection of the wheel speed and the magnetized vehicle wheel, already mentioned above, for the detection of dynamic forces according to the SWT principle (Sidewall Torsion Sensors).

Sensor arrangements for the detection of air gap modulations by means of an encoder are generally known. For instance, they also serve for the determination of crankshaft and camshaft positions in motor vehicle engines. In another classical case of application, the measurement of wheel speeds, an incremental encoder track periodically modulates the magnetic field strength in the air gap between two fixed values. An additional change of the kinematics between the sensor and the encoder through dynamic forces during driving operation and the herewith additionally occurring modulation of the field strength is undesirable in this application and is suppressed during signal-conditioning.

To this end, the so-called active sensors known from the prior art for ABS wheel speed detection contain an internal amplifier/trigger circuit that effects that, regardless of the air gap dynamics, always a square wave signal with two constant amplitudes is generated, whose edge change follows the encoder track.

For the detection of driving-dynamical states (ESP) of a motor vehicle, e.g. during cornering, it is suggested, for example in DE 44 42 355 A1, to draw on the value of an elastic axle deformation and, for its measurement, to use the width of the air gap between a wheel speed sensor and its respective encoder.

For the determination of longitudinal and lateral forces, it is known from DE 44 35 160 A1 to detect as well the phase of two wheel speed sensor signals as their variable signal amplitudes on a magnetically encoded tire via air gap deformations.

The objective of the present invention is to provide a concept equally suitable for all above-described sensor types, in which concept modular sensor units are formed, whose basic system is suitable for all sensors. It is further the objective of the present invention to create a sensor, in particular an SWT sensor, suitable for this concept of the formation of common units.

This objective is achieved, according to the invention, by means of the features of the patent claims 1 and 6, respectively.

A first inventive idea consists in generally designing future sensor units constructively in a way that their housing dimensions and outer shape is identical or nearly identical with sensor elements already in use for the production of active ABS wheel speed sensors (ready to use with cable and plug). This yields the advantage that, for the introduction of series production of novel sensors, e.g. SWT sensors, the same production tools can be used as for active wheel speed sensors.

Due to the great variety of different series programs for active sensors, there is an abundance of already existing different shape designs and constructive embodiments of active wheel speed sensors with the corresponding production tools, from which matching shapes can be steadily adopted for SWT sensors. In this way, the development expenditure is minimized, and the advantage is attained that also small SWT equipment numbers can be served economically. This basic thought also applies to future active sensors for wheel speed detection.

Further on, using the above concept, an inventive arrangement is described with which air gap modulations of any kind can be detected so that with these, beside the wheel speed, also air gap changes can be measured as a function of deformation forces. These sensors are particularly suitable for the realization of the sidewall torsion concept, yet as well for the realization of sensor systems for ESP based on DE 44 42 355 A1.

Further advantages and preferred embodiments of the present invention arise from the subclaims as well as from the following description in connection with the attached drawings. In the drawings,

Fig. 1 a shows a basic structure of the inventive sensor unit;
Fig. 1 b-c show different variants of sensors based on the same concept;
Fig. 2 a-b show schematic illustrations of sensor circuits with functional blocks; and
Fig. 3 a-b show the course of signal currents J_1 and J_2 over the time.

In connection with Fig. 1 a-d, at first a general concept for the standardized design of units for the active-sensor scanning of encoders is described, which are processed into ready-made sensors (probes) or which comprise common modular units according to the invention, respectively.

Fig 1a shows an outer housing shape or basic structure, respectively, of a general sensor element according to the inventive design concept. Here reference numeral 1 identifies a housing or head 1, preferably made of plastic, in which always some magneto-electric converter element is embedded. 2 identifies a housing, preferably made of plastic, that further on will also be called body 2. In body 2, there is always embedded some electronic signal processing circuit. The intended application determines what converter element is contained in head 1 and what signal processing circuit in body 2. A permanent 4-pole electric connection 3 extends between head 1 and body 2. For a 2-wire connection to a control device, a pin 4 serves as signal output and a pin 5 for the supply with operating voltage.

Figures 1b, 1c, and 1d show the general housing shape according to Fig. 1a combined with three differently sized magnets 6, 7, and 8. These magnets serve for the demand-assigned different magnetic pre-load of electro-magnetic converters in head 1. Following the inventive thought of the design concept, three different magnets 6,7,8 have fixed dimensions so that general design variants exist now, whose content can be exchanged or adapted in head 1 or body 2 according to the application.

In an advantageous application, the constructive dimensions of the design variants correspond at the same time those of already existing active wheel speed sensors.

A further advantage of the inventive design concept consists in always realizing the following four interface properties. A 2-wire connection to the control device, operation with a wide range of uncontrolled supply voltage, load-independent current as carrier of the output signal as well as a continuous frequency resolution up to the standstill of the encoder.

Preferably, magneto-electric converters are exclusively used which are based on XMR technologies (concerning this, see Verlag VDI-Technologiezentrum, Düsseldorf, "Technologieanalyse Magnetismus", Vol. 2). Here particularly AMR technology (anisotropic magneto-resistance) and GMR (giant magneto-resistance).

The design variants are consistently used with a significant advantage as follows: The variant according to Fig. 1a in combination with permanent-magnetic encoders, the design variant according to Fig. 1b in combination with ferromagnetic encoders, the design variant according to Fig. 1c in combination with ferromagnetic encoders, and the variant according to Fig. 1d in combination with permanent-magnetic encoders.

Applications of the new design concept according to the invention are, among others, active wheel speed sensors with digital offset compensation according to patent application DE 198 15 084 A1, in which the head 1 comprises a magneto-resistive bridge and a Barber pole structure as well as an ASIC for digital offset compensation. ASICs are integrated circuits (ICs) specifically designed for the application.

Additionally, the invention is suitable for active wheel speed sensors with transmission of additional information and a novel data protocol according to DE 196 34 715 A1. A head 1 with magneto-resistive bridge and Barber pole structure, in which an IC or ASIC is employed for the recognition of direction and for the diagnosis of the air gap, is also conceivable.

Another conceivable application of the inventive sensor unit is an active sensor for the simultaneous detection of wheel speed and dynamic air gap deformation. Such a sensor can be utilized with a significant advantage for ESP or SWT, respectively. In this case, the sensor preferably includes a head 1 with a magneto-resistive bridge and a body 2 with an ASIC, in particular of the type UA1272. Preferably, this sensor is designed according to one of the design variants according to Fig. 1 b-d.

Subsequently, such a sensor according to the invention as well as its adaptation to the inventive concept of the sensor units is described in further detail. The intended components of realization are mentioned in the preceding paragraph. The variants of the constructive completion follow the guideline of the design concept claimed by the invention.

As previously explained, There are sensor elements for active wheel speed sensors, which can be integrated into the design concept and are currently manufactured in large numbers. To this end, Fig. 2b shows a schematic illustration of an electronic circuit with functional blocks of a n active wheel speed sensor, and Fig. 2a shows a schematic illustration of the sensor according to the invention. Both depictions show at the same

time the constructive allocation of the functional blocks into the superordinate design concept according to Fig. 1.

Preferably the same crystal module should be used for the detection of the air gap modulation that is already present as a standard component of sensor elements for active ABS wheel speed sensors and manufactured in large numbers. This yields the economic advantage that also small SWT equipment numbers can be served more economically. At the same time, the total number of crystal modules produced is increased, which become cheaper that way.

Both heads 1 contain a magnetoresistive bridge circuit 9 of the same type. The magneto-electric converters 9 are, via an air gap not depicted here, magnetically coupled to a permanent-magnetic encoder track 10, which is preferably arranged in the sidewall of a magnetized tire or in a magnetized wheel bearing seal. The heads 1 are connected to the bodies 2 through the mentioned 4-pole connections 3. To the respective control device, there is the above-mentioned 2-wire connection via pin 4 and pin 5.

The voltage supply V_{cc} is established via the respective pin 5 from an electric control or regulating unit for the brake system. The signal processing circuits contained in bodies 2 differ by the schematically shown units 12 and 13 so that the signal currents J_1 and J_2 are significantly different, too.

In the known active sensor according to Fig. 2b, every fluctuation of amplitude, caused by dynamic air gap deformation, is suppressed by an amplifier or trigger stage, and the signal is shaped into an accurate, load-independent rectangular signal current J_2 with two constant amplitudes so that the transmitted

information is limited to the wheel speed which is mapped in the sequence of edges.

In the inventive arrangement according to Fig. 2a, however, there is located an electronic circuit 12 amplifying and processing the signal so that a signal current J_1 is supplied to the control device 11, from which signal current additionally, beside the wheel speed information 14, the gauge of the amplitude can be gathered as a measurement for the thickness of the air gap 15 and the phase relation 16 to a reference signal.

Figs. 3a and 3b clarify once more the differences of the signal currents J_1 and J_2 between the known active sensor of Fig. 3b and the inventive sensor according to Fig. 3a under the same interface conditions to the encoder. Under the presumption of an air gap variation shown here, both sensors map the same wheel speed, however, only the inventive sensor additionally also the amplitude changing with the air gap width.

In an advantageous embodiment of the invention for the realization of an SWT sensor, the previously described arrangement can for instance be designed according to the following characteristics:

To this end, the SWT sensor has a magnetic sensitivity (output current amplitude/encoder field strength) of S = .75 mA/[kA/m], an output current amplitude range of J = 11 mA ± 4 mA lift, a terminal voltage range at pin 4 of V_{CC} = 5 to 16 V, and an output impedance of ≥ 10 kOhm.

The magnetized tire sidewall as encoder track can, for instance, be equipped with a pole pattern of 48 north/south pole pairs per 360° sidewall and with a magnetic field strength amplitude of .8 kA/m at 10 mm air gap.

In an advantageous embodiment of the invention for the realization of an SWT sensor, the sensor arrangement is realized according to the inventive design concept by utilizing the following units. Head 1 comprises a magnetoresistive bridge 9, body 2 includes an ASIC of the type UA1272. Preferably, the sensor is designed according to the embodiment of Fig. 1b, 1c, or 1d.

Patent Claims

1. Sensor unit for vehicles, particularly motor vehicles, **characterized** by a first housing (1) for the accommodation of at least one converter element,
a second housing (2) for the accommodation of a signal processing unit,
an at least 4-pole connection (3) between the first and the second housing, and
a port (4,5) of the second housing for a control device.

2. Sensor unit according to claim 1, **characterized** in that the port is designed as a 2-wire-connection, with a pin (4) as signal output and a pin (5) for the supply of operating voltage.

3. Sensor unit according to claim 1 or 2, **characterized** in that the converter element is designed as a magneto-electric converter, preferably as a magnetoresistive bridge (9).

4. Sensor unit according to any one of claims 1 to 3, **characterized** in that the first housing (1) comprises functional elements for positioning or carrying at least one magnet (6,7,8) used for pre-loading the magneto-electric converter elements.

5. Sensor unit according to any one of claims 1 to 4, **characterized** in that the signal processing unit arranged in housing (2) is designed as an analog amplifier with a current output via pin (4) and provides an alternating current with an approximately sinusoidal course.

6. Sensor for vehicles, **characterized** by a design according to one of the claims 1 to 5.

7. Sensor according to claim 6, **characterized** by a design as a wheel speed sensor.

8. Sensor according to claim 6, **characterized** by a design as a tire force sensor.

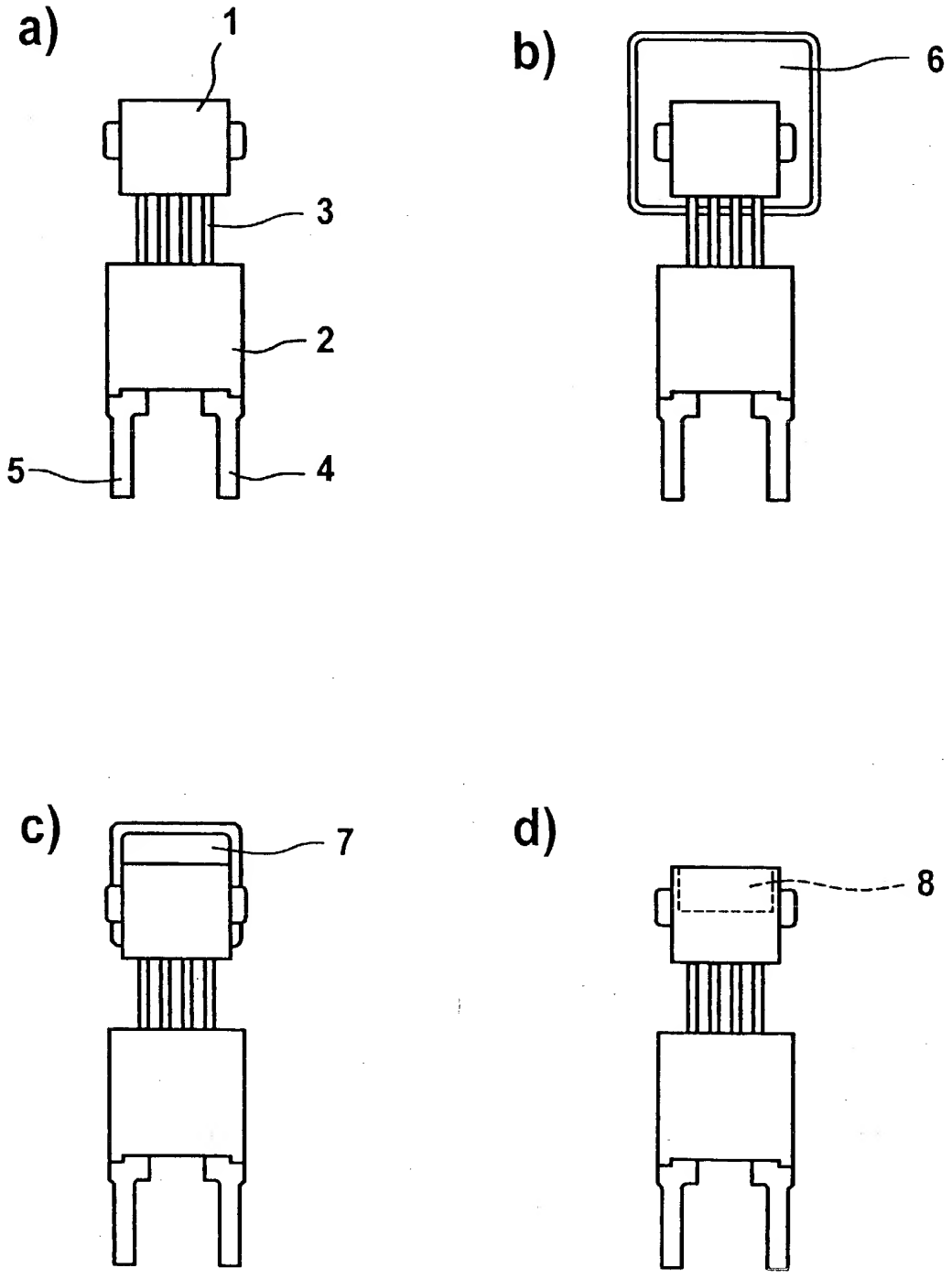
9. Sensor according to claim 6 or 8, **characterized** by a housing (1), in which a magnetoresistive bridge (9) is arranged, a housing (2), in which an analog amplifier is arranged having a current output that provides an alternating current with an approximately sinusoidal course, an at least 4-pole connection (3) between first and second housings, and a port with a pin (4) and a pin (5), which establishes the current output.

Abstract

Sensor unit and sensor for such a unit

The invention relates to a sensor unit and a sensor for such a unit for vehicles, in particular motor vehicles. According to the invention, in order to provide a concept equally suitable for different sensor types, in which modular sensor units are formed and whose basic system is suitable for all sensors, a first housing (1) for the accommodation of at least one converter element a second housing (2) for the accommodation of a signal processing unit, an at least 4-pole connection (3) between the first and the second housing, and a port (4,5) of the second housing (2) for a control device are provided. (Fig. 1)

Fig. 1



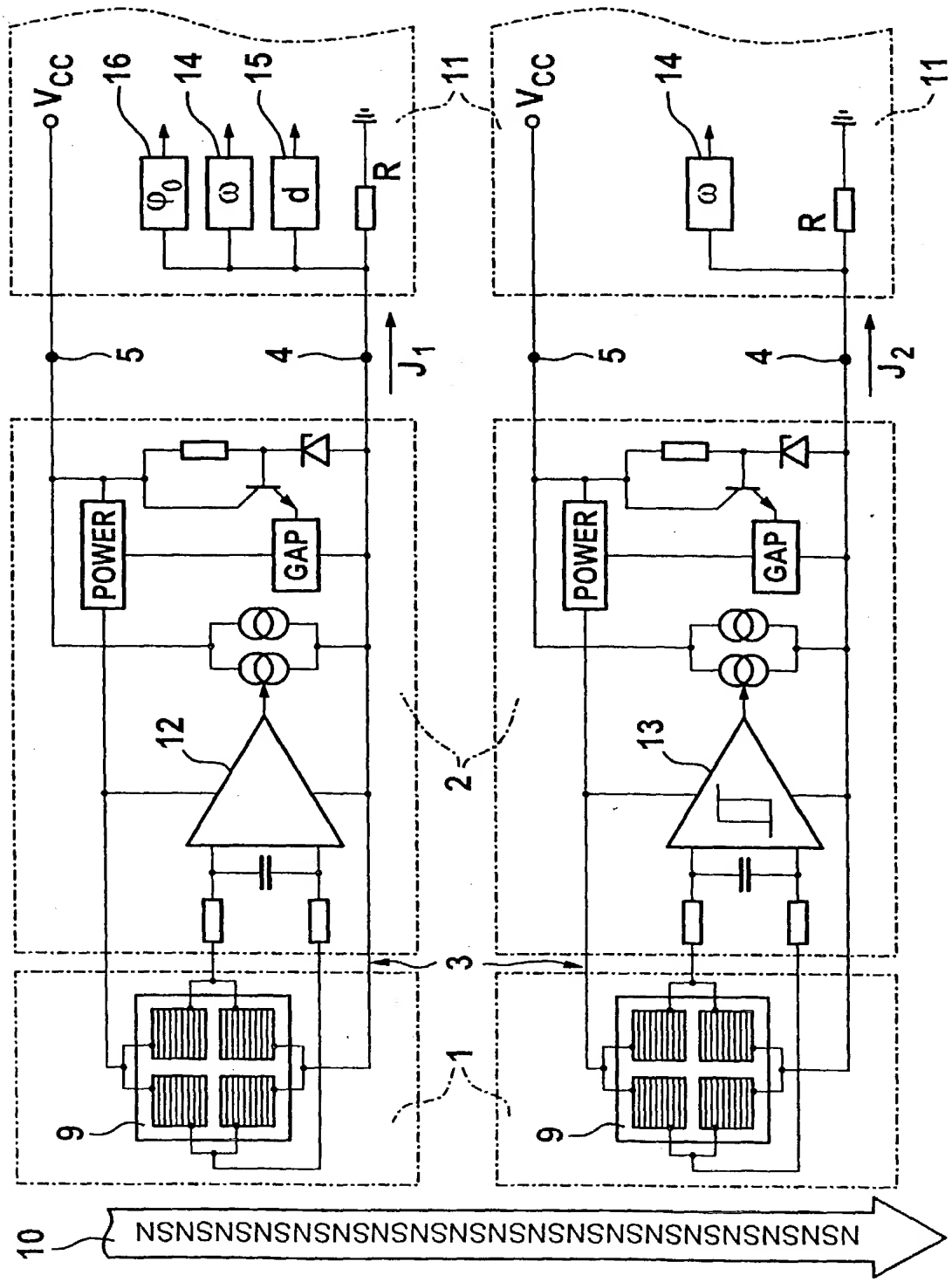
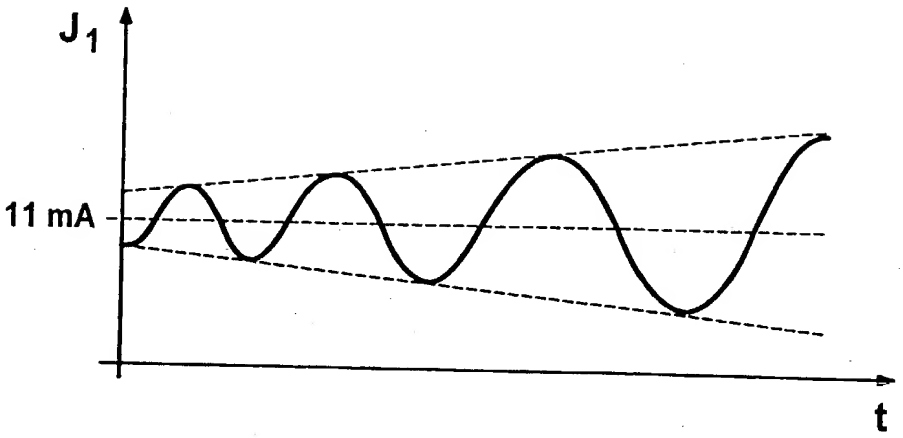

V_{CC}
16
14
15
11
φ_0
ω
d
R
5
4
J_1
J_2
POWER
GAP
12
13
2
3
1
9
10
NSNSNSNSNSNSNSNSNSNSNSNSNSNSNSNSNSN
a)
b)

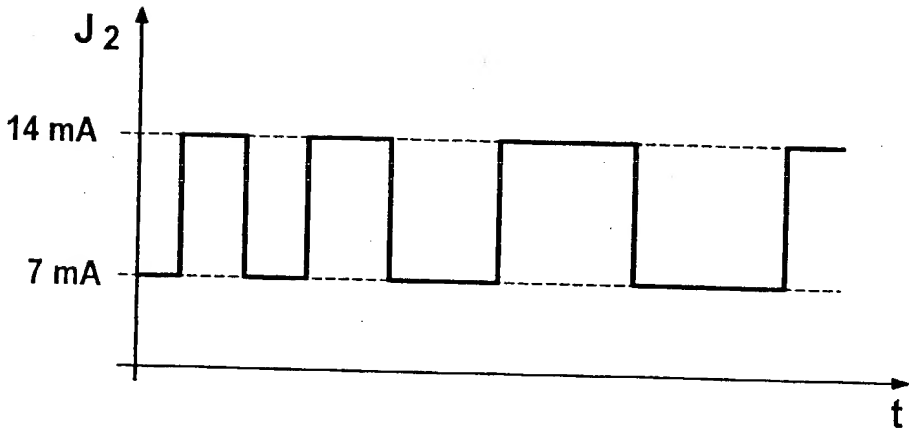
Fig. 2

Fig. 3

a)



b)



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Declaration and Power of Attorney for Patent Application
Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

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My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Sensor Assembly and Sensor for Such an Assembly

deren Beschreibung hier beigefügt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

the specification of which is attached hereto unless the following box is checked:

wurde angemeldet am
unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT).

was filed on **18/MAY/2000**
as United States Application Number or PCT International Application Number
PCT/EP00/04498

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die durch einen oben erwähnten Zusatzantrag und in einem "preliminary amendment" abgeändert wurden, durchgesehen und verstanden habe.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above and as amended in a preliminary amendment.

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I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

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Prior Foreign Applications (Frühere ausländische Anmeldungen)		Priority Not Claimed Priorität nicht beansprucht
19922672.5	**Germany**	**18/MAY/1999**
Number	Country	Day/Month/Year Filed

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s)listed below.

Application No. , filed on

Application No. , filed on

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Application No. , filed on — Status: patented/pending/abandoned

Application No. , filed on — Status: patented/pending/abandoned

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VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den (die) nachstehend aufgeführten Patentanwalt (Patentanwälte) und/oder Vertreter mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent- und Markenamt:

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If box is checked, subsequent inventors are listed on a separate sheet

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